



## The evolving art of carbo-loading

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For Active.com

April 13, 2006

The practice of carbo-loading dates back to the late 1960s. The first carbo-loading protocol was developed by a Swedish physiologist named Gunvar Ahlborg after he discovered a positive relationship between the amount of glycogen (carbs stored in the muscles and liver) in the body and endurance performance.

Scientists and runners had already known for some time that eating a high-carbohydrate diet in the days preceding a long race enhances performance, but no one knew exactly why until Ahlborg's team zeroed in on the glycogen connection.

Subsequently, Ahlborg discovered that the muscles and liver are able to store above-normal amounts of glycogen when high levels of carbohydrate consumption are preceded by severe glycogen depletion. The most obvious way to deplete the muscles of glycogen is to eat extremely small amounts of carbohydrate. A second way is to engage in exhaustive exercise.

The stress of severe glycogen depletion triggers an adaptive response by which the body reduces the amount of dietary carbohydrate that it converts to fat and stores, and increases the amount of carbohydrate that it stores in the liver and muscles as glycogen.

Ahlborg referred to this phenomenon as glycogen supercompensation. Armed with this knowledge, he was able to create a more sophisticated carbo-loading protocol than the primitive existing method, which was, more or less, eating a big bowl of spaghetti.

### The Ahlborg method

Ahlborg came up with a seven-day carbo-loading plan in which an exhaustive bout of exercise was followed by three or four days of extremely low carbohydrate intake (10 percent of total calories) and then three or four days of extremely high carbohydrate intake (90 percent of total calories).

Trained athletes who used this protocol in an experiment were able to nearly double their glycogen stores and exhibited significantly greater endurance in exercise lasting longer than 90 minutes.

After these results were published, endurance athletes across the globe began to use Ahlborg's carbo-loading plan prior to events anticipated to last 90 minutes or longer. While it worked admirably, it had its share of drawbacks.

First of all, many athletes weren't keen on performing an exhaustive workout just a week before a big race, as the plan required. Second, maintaining a 10 percent carbohydrate diet for three or four days carried some nasty consequences including lethargy, cravings, irritability, lack of concentration and increased susceptibility to illness. Many runners and other athletes found it just wasn't worth it.

#### The Ahlborg Carbo-Loading Method

1. Perform an exhaustive workout one week before a long race (90 minutes-plus).
2. Consume a very low-carb diet (10%) for the next 3-4 days while training lightly.
3. Consume a very high-carb diet (90%) the next 3-4 days while continuing to train lightly.

### The no-depletion method

Fortunately, later research showed that you can increase glycogen storage significantly without first depleting it. A newer carbo-loading protocol based on this research calls for athletes to eat a normal diet of 55 to 60 percent carbohydrate until three days before racing, and then switch to a 70 percent carbohydrate diet for the final three days, plus race morning.

#### **The No-Depletion Carbo-Loading Method**

1. Perform a long workout (but not an exhaustive workout) one week before race day.
2. Eat normally (55-60% carbohydrate) until three days before a longer race.
3. Eat a high-carb diet (70%) the final three days before racing while training very lightly.

As for exercise, this tamer carbo-loading method suggests one last longer workout (but not an exhaustive workout) done a week from race day followed by increasingly shorter workouts throughout race week. It's simple, it's non-excruciating, and it works. Admittedly, some scientists and athletes still swear that the Ahlberg protocol is more effective, but if it is, the difference is slight and probably not worth the suffering and inherent risks.

Note that you should increase your carbohydrate intake not by increasing your total caloric intake, but rather by reducing fat and protein intake in an amount that equals or slightly exceeds the amount of carbohydrate you add. Combining less training with more total calories could result in last-minute weight gain that will only slow you down.

Be aware, too, that for every gram of carbohydrate the body stores, it also stores 3 to 5 grams of water, which leads many athletes to feel bloated by the end of a three-day loading period. The water weight will be long gone by the time you finish your race, however.

### **The Western Australia method**

The newest and perhaps the best of all the carbo-loading strategies was devised in 2002 by scientists at the University of Western Australia. It combines depletion and loading and condenses them into a one-day time frame.

The creators of this innovative protocol recognized that a single, short workout performed at extremely high intensity creates a powerful demand for glycogen storage in both the slow-twitch and fast-twitch fibers of the muscles. They hypothesized that following such a workout with heavy carbohydrate intake could result in a high level of glycogen supercompensation without a lot of fuss.

In an experiment, the researchers asked athletes to perform a short-duration, high-intensity workout consisting of two and a half minutes at 130 percent of  $VO_2$ max (about one-mile race pace) followed by a 30-second sprint. During the next 24 hours, the athletes consumed 12 grams of carbohydrate per kilogram of lean muscle mass. This resulted in a 90-percent increase in muscle glycogen storage.

Runners have cause to be very pleased by these findings. Doing just a few minutes of high-intensity exercise the day before a competition will not sabotage tomorrow's performance, yet it will suffice to stimulate the desirable carbohydrate "sponging" effect that was sought in the original Ahlberg protocol. This allows the athlete to maintain a normal diet right up until the day before competition and then load in the final 24 hours.

The Western Australia carbo-loading strategy works best if preceded by a proper taper -- that is, by several days of reduced training whose purpose is to render your body rested, regenerated, and race-ready. In fact, several days of reduced training combined with your normal diet will substantially increase your glycogen storage level even before the final day's workout and carbohydrate binge.

#### **The Western Australia Carbo-Loading Method**

1. During the pre-race week, eat normally while training lightly until the day before a longer race.
2. On the morning of the day before the race, perform a very brief, very high-intensity workout.
3. Consume 12 g of carbs per lb. of body weight over the next 24 hours.

When you exercise vigorously almost every day, your body never gets a chance to fully replenish its glycogen stores before the next workout reduces them again. Only after 48 hours of very light training or complete rest are your glycogen levels fully compensated. Then the Western Australia carbo-loading regimen can be used to

achieve glycogen supercompensation.

Having said all of this, I would like to note finally that carbo-loading in general has been shown to enhance race performance only when athletes consume little or no carbohydrate during the race itself. If you do use a sports drink or sports gels to fuel your race effort -- as you should -- prior carbo-loading probably will have no effect. But it doesn't hurt to do it anyway, as insurance.

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*Matt Fitzgerald is the author of several books on triathlon, running, and sports nutrition, including [Runner's World Performance Nutrition for Runners](#) (Rodale, 2005).*

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